TITLE

DRIVING METHOD FOR ACTIVE MATRIX OLED DISPLAY

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a driving method, and more particularly, to a driving method for an active matrix OLED display, as well as a pixel structure using the same.

Description of the Related Art

Typically, an active matrix OLED display employs a large number of pixels to present an image, and controls the brightness of each pixel according to a brightness data.

Fig. 1 shows a pixel structure 10 of an active matrix organic light emitting diode (AMOLED). The switching transistor T_1 is turned on and a data voltage indicated brightness is applied to a data electrode DATA when the scan electrode SCAN is activated. Thus, the storage capacitor C_s is charged or discharged, and the potential at the gate of the driving transistor T_2 may coincide with that of the data voltage. The switching transistor T_1 is turned off and the driving transistor T_2 is electrically isolated from the data electrode DATA when the scan electrode SCAN is not activated. The data voltage is stored in the storage capacitor C_s, and the potential at the gate of the driving transistor T_2 is maintained. The produced driving current I flows to the OLED 20 through the driving transistor T_2 according to the voltage (Vgs) between the gate and source of the driving transistor T_2. The OLED 20 then continuously illuminates according to the driving current I.

That is, in one display frame, the current received by the OLED is fixed. However, this driving method accumulates carriers inside the OLED 20 which reduce the life of the OLEDs. Moreover, the voltage V_o across the OLED gradually increases over time as shown in Fig. 3. Further, as shown by the formula $P = I \times V$, as the voltage V_o increases over time, the power P also increases. In Fig. 3, curve C_1 shows the effect of the voltage V_o of the OLED over time.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to neutralize carrier accumulation in the OLED of an LCD, thereby reducing the increase in voltage and minimizing the increase in power consumption across both ends of the OLED over time, further increasing the life of the OLED.

According to the above mentioned objects, the present invention provides a driving method for an active matrix OLED display. The driving method provides a first current to flow through an OLED of a pixel in a first period of one display period, according to a video signal on the data electrode and a scan signal on the scan electrode. Next, a second current is provided to flow through the OLED in a second period of the display period to neutralize carrier accumulation inside the OLED. Wherein the first current and the second current flow in opposite directions.

According to the above mentioned objects, the present invention provides a pixel structure of an active matrix OLED display, which is capable of neutralizing carrier accumulation in an OLED. In the pixel structure of the present invention, a switching transistor has a control terminal

coupled to a scan electrode and a first terminal coupled to a data electrode. A driving transistor has a control terminal coupled to a second electrode of the switching transistor and a first terminal coupled to a power voltage. An OLED has an anode coupled to the second terminal of the driving transistor, and a cathode coupled to a common electrode. A storage capacitor has one terminal coupled to the control terminal of the driving transistor. A neutralization control circuit is coupled between the OLED and a first voltage, according to a control signal, to pull down the potential at the anode of the OLED thereby inducing a reverse current to neutralize the carrier accumulation in the OLED. The potential of the first voltage is lower than that at the cathode of the OLED.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention can be more fully understood by reading the subsequent detailed description and examples with reference made to the accompanying drawings, wherein:

Fig. 1 shows a pixel structure of a conventional active matrix OLED display;

Fig.2 is a schematic diagram illustrating a conventional driving method for active matrix OLED display;

Fig. 3 shows the relationship between the voltage across both ends of the OLED and its life in the conventional pixel structure;

Fig.4 is a diagram illustrating a driving method of the present invention;

Fig. 5 shows the pixel structure of an active matrix OLED display according to the present invention;

Fig.6 is another diagram illustrating the driving method of the present invention;

Fig. 7 shows the relationship between the voltage across both ends of the OLED and its life using the conventional driving method and that of the present invention; and

Fig. 8 shows the relationship between the brightness and OLED life according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Fig. 4 shows a pixel structure 100 of an active matrix OLED display. In the pixel structure 100, the switching transistor T_{11} has a control terminal coupled to a scan electrode SCAN, and a first terminal coupled to a data electrode DATA. A driving transistor T_{21} has a control terminal coupled to a second terminal of the switching transistor T_{11}, and a first terminal coupled to a power voltage V_{DD}. An OLED 20 has an anode coupled to the second terminal of the driving transistor T_{21}, and a cathode coupled to a common electrode (not shown), wherein the common electrode has a potential of V_{COM}. A storage capacitor C_{11} has one terminal coupled to the control terminal of the driving transistor T_{21}.

The driving method of the present invention is described below with reference to Fig. 4 and Fig. 6. First, in a first period T_f of one display frame N, a first current is provided and flows through the OLED 20 according to a data signal on the electrode DATA and a scan signal on the scan electrode SCAN. That is, the switching transistor T_{11} is turned on and the storage capacitor C_{11} is charged or discharged by the data signal on the data electrode DATA according to the scan signal on the scan electrode SCAN. At this time, the gate voltage

of the driving transistor T_{21} can be adjusted and stored in the storage capacitor C_{11}. The driving transistor T_{21} provides the first current I_f to flow through the OLED 20 according to the gate voltage of the transistor T_{21}, and the OLED illuminates accordingly. The switching transistor T_{11} is then turned off, but driving transistor T_{21} is still turned on according to the voltage stored in the storage capacitor C_{11}, and the OLED 20 illuminates with the same brightness. Because of the above mentioned step, carrier accumulation in the OLED 20, and further, the voltage across both ends of the OLED 20 increases as over time. Thus, the effective life of the OLED 20 may be reduced.

In view of this, the present invention provides a step of providing a second current I_r opposite to the first current I_f to flow through the OLED in a second period T_r of the display frame N. For example, the current I_f flows from anode to cathode and the current I_r flows from cathode to anode, and vice versa. In the present invention neutralizes carrier accumulation in the OLED 20 by the second current I_r. The time ratio of the first period T_f to the second period T_r can be between 1:1 ~10^5:1, for example 10:1.

In this embodiment, the second current I_r is obtained by pulling up the potential V_{COM} at the cathode of the OLED higher than the power voltage V_{DD}. As the potential V_{COM} at the cathode of the OLED 20 is higher than the power voltage V_{DD}, the potential V_{COM} is higher than the voltage V_r at the anode of the OLED 20. Thus, the voltage V_o across the OLED 20 becomes negative, and the second current I_r opposite to the first current I_f is produced to neutralize the carrier accumulation in the OLED 20. In addition, the second current I_r opposite

to the first current I_f can also be obtained by providing a negative voltage across the anode and cathode of the OLED. Alternately, the second current I_r can be provided to flow through the OLED 20 before each first period T_f (first current I_f) of the display frame N.

Additionally, the present invention provides a pixel structure capable of neutralizing carrier accumulation in OLED, as shown in Fig. 5. In Fig. 5, a switching transistor T_{11} has a control terminal coupled to a scan electrode SCAN and a first terminal coupled to a data electrode DATA. A driving transistor T_{21} has a control terminal coupled to a second electrode of the switching transistor T_{11} and a first terminal coupled to a power voltage V_{DD}. The OLED 20 has an anode coupled to the second terminal of the driving transistor T_{21}, and a cathode coupled to a common electrode (not shown). A storage capacitor C_{11} has one terminal coupled to the control terminal of the driving transistor T_{21}.

The present invention utilizes a transistor T_3 as a neutralization control circuit coupled between the OLED and a first voltage V_s, wherein the potential of the first voltage V_s is lower than the potential V_{COM} at the cathode of the OLED 20. In the second period T_r of the display frame N, the transistor T_3 pulls the potential V_r at the anode of the OLED 20 lower than the potential V_{COM}, according to a control signal S_1. At this time, the voltage V_o across the OLED 20 becomes negative, and thus a reverse current I_r opposite to the current I_f is induced to neutralize carrier accumulation in the OLED 20. For example, the current I_f flows from anode to cathode and the current I_r flows from cathode to anode, and vice versa. The time ratio of the first period T_f (current I_f) between and

the second period T_r (current I_r) can be 1:1 ~10^5:1, for example 10:1. The embodiment of the present invention for producing a reverse current to flow through an OLED is provided as an example, and is not intended to constrain the application of this invention.

Fig. 7 shows the relationship between the voltage V_o across both ends of the OLED 20 and its life using the conventional driving method and the method of the present invention. Curve C_1 shows the relationship between the voltage V_o across both ends of the OLED 20 and its life in the present invention. Curve C_2 show the relationship between the voltage V_o across both ends of the OLED and its life using the conventional driving method. Obviously, the present invention can reduce increased voltage across both ends of the OLED over time. Additionally, the present invention can also reduce increased power consumption of to OLED over time, as shown by the formula $P = I \times V$.

Fig. 8 shows the relationship between the brightness and the life of an OLED according to the present invention. In Fig. 8, curve C_3 shows the relationship between the brightness and the life of an OLED without using a reverse current to neutralize carrier accumulation in the OLED. Curve C_4 shows the relationship between the brightness and the life of an OLED with a reverse current I_r to neutralize carrier accumulation in the OLED, wherein the time ratio of the first period T_f (current I_f) to the second period T_r (current I_r) is 10:1. Curve C5 shows the relationship between the brightness and the life of an OLED using the reverse current, wherein the time ratio of the first period T_f (current I_f) to the second period T_r (current I_r) is 100:1. Curve C_5 shows the

relationship between the brightness and the life of an OLED with the reverse current, wherein time ratio of the first period T_f (current I_f) to the second period T_r (current I_r) is 500:1. As shown in Fig. 8, the life of OLED using a reverse current to neutralize carrier accumulation therein is about double of the conventional OLED and driving method not employing reverse current. Therefore, the present invention reduces the increase in voltage and minimizes the increase in power consumption across both ends of the OLED over time, further increasing the life of the OLED.

Furthermore, in the present invention, a period for producing a reverse current to neutralize carrier accumulation in the OLED is not limited to one display frame but extend to two or more display frames. For example, the first, fourth and seventh display frames each have a period for producing a reverse current to neutralize carrier accumulation in the OLED. The second, third, fifth and sixth display frames have no period for producing a reverse current to neutralize carrier accumulation in an OLED.

While the invention has been described by way of example and in terms of the preferred embodiments, it is to be understood that the invention is not limited to the disclosed embodiments. To the contrary, it is intended to cover various modifications and similar arrangements (as would be apparent to those skilled in the art). Therefore, the scope of the appended claims should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements.